Decision Rationale
Total Maximum Daily Load of
Fecal Coliform for Mill Creek

I. Introduction

This document will set forth the Environmental Protection Agency's (EPA) rationale for approving the Total Maximum Daily Load (TMDL) of Fecal Coliform for Mill Creek submitted for final Agency review on February 08, 2001. Our rationale is based on the TMDL submittal document to determine if the TMDL meets the following 8 regulatory conditions pursuant to 40 CFR §130.

1. The TMDLs are designed to implement applicable water quality standards.
2. The TMDLs include a total allowable load as well as individual waste load allocations and load allocations.
3. The TMDLs consider the impacts of background pollutant contributions.
4. The TMDLs consider critical environmental conditions.
5. The TMDLs consider seasonal environmental variations.
6. The TMDLs include a margin of safety.
7. The TMDLs have been subject to public participation.
8. There is reasonable assurance that the TMDLs can be met.

II. Background

Located in Rockingham County, Virginia, the overall Mill Creek watershed is approximately 9,633 acres. The TMDL addresses 2.66 miles of Mill Creek beginning at its headwaters and continuing to its confluence with the North River. Agriculture is the dominant land use in the watershed. Mill Creek is a tributary to the North River which flows into the S.F. Shenandoah, which flows into the Potomac, which discharges to the Chesapeake Bay.

In response to Section 303 (d) of the Clean Water Act (CWA), the Virginia Department of Environmental Quality (VADEQ) listed 2.66 miles of Mill Creek as being impaired by elevated levels of fecal coliform on Virginia's 1998 303 (d) list. Mill Creek was listed for violations of Virginia's fecal coliform bacteria standard for primary contact. Fecal coliform is a bacterium which can be found within the intestinal tract of all warm blooded animals. Fecal coliform can therefore be found in the fecal wastes of warm blooded animals. Fecal coliform in itself is not a pathogenic organism. However, fecal coliform indicates the presence of fecal wastes and the potential for the existence of other pathogenic bacteria. The higher concentrations of fecal coliform indicate the elevated likelihood of increased pathogenic organisms. Mill Creek, identified as watershed VAV-B29R, was given a high priority for TMDL development. Section 303 (d) of the Clean Water Act and its implementing regulations require a TMDL to be developed for those waterbodies identified as impaired by the State where technology-based and other controls do not provide for the attainment of Water Quality Standards. The TMDL submitted by Virginia is designed to determine the acceptable load of fecal coliform which can be delivered to Mill Creek, as demonstrated by the Hydrologic

Simulation Program Fortran (HSPF)[1], in order to ensure that the water quality standard is attained and maintained. These levels of fecal coliform will ensure that the Primary Contact usage is supported. HSPF is considered an appropriate model to analyze this watershed because of its dynamic ability to simulate both watershed loading and receiving water quality over a wide range of conditions.

EPA has been encouraging the States to use e-coli and enterococci as the indicator species instead of fecal coliform. A better correlation has been drawn between the concentrations of e-coli (and enterococci) and the incidence of gastrointestinal illness. The Commonwealth is pursuing changing the standard from fecal coliform to e-coli.

Virginia designates all of its waters for primary contact, therefore all waters must meet the current fecal coliform standard for primary contact. Virginia's standard is to apply to all streams designated as primary contact for all flows. Through the development of this and other similar TMDLs it was discovered that natural conditions (wildlife contributions to the streams) were causing violations of the standard during low flows. Thus many of Virginia's TMDLs have called for some reduction in the amount of wildlife contributions to the stream. EPA believes that a significant reduction in wildlife is not practical and will not be necessary due to implementation discussion below.

A phased implementation plan will be developed for all streams in which the TMDL calls for reductions in wildlife. The first phase of the implementation will reduce all sources of fecal coliform to the stream other than wildlife. In phase 2, which can occur concurrently to phase 1, the Commonwealth will consider addressing its standards to accommodate this natural loading condition. During phase 2, the Commonwealth has indicated that it will evaluate the following items in relation to the standard. 1) The possibility of placing a minimum flow requirement upon the bacteriological standard. As a result, the standard may not apply to flows below the minimum (possibly 7Q10). This application of the standard is applied in many States. 2) The Commonwealth may develop a Use Attainability Analysis (UAA) for streams with wildlife reductions which are not used for frequent bathing. Depending upon the result of that UAA, it is possible that these streams could be designated primary contact infrequent bathing. 3) The Commonwealth will also investigate incorporating a natural background condition for the bacteriological indicator.

After the completion of phase 1 of the implementation plan the Commonwealth will monitor to determine if the wildlife reductions are actually necessary, as the violation rate associated with the wildlife loading may be smaller than the percent error of the model. In phase 3, the Commonwealth will investigate the sampling data to determine if further load reductions are needed in order for these waters to attain standards. If the load reductions and/or the new application of standards allow the stream to attain standards, then no additional work is warranted. However, if standards are still not being

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[1]Bicknell, B.R., J.C. Imhoff, J.L. Little, and R.C. Johanson. 1993. Hydrologic Simulation Program-FORTRAN (HSPF): User's Manual for release 10.0. EPA 600/3-84-066. U.S. Environmental Protection Agency, Environmental Research Laboratory, Athens, GA.

attained after the implementation of phases 1 and 2 further work and reductions will be warranted.

The TMDL analysis allocates the application/deposition of fecal coliform to land based and instream sources. For land based sources the HSPF model accounts for the buildup and washoff of pollutants from these areas. Build up (accumulation) refers to all of the complex spectrum of dry-weather processes that deposit or remove pollutants between storms. Washoff is the removal of fecal coliform which occurs as a result of runoff associated with storm events. These two processes allow the HSPF model to determine the amount of fecal coliform from land based sources which is reaching the stream. Point sources and wastes deposited directly to the stream were treated as direct deposits. These wastes did not need a transport mechanism to allow them to reach the stream. The allocation plan calls for the reduction in fecal coliform wastes delivered by cattle in-stream and wildlife in-stream. Wildlife loading alone cause violations in the standard.

Table #1 summarizes the specific elements of the TMDL.

Parameter	TMDL(cfu/yr)	WLA(cfu/yr)	LA(cfu/yr)	*MOS* [1] (cfu/yr)
Fecal Coliform	1,681.0 x 10^{12}	0.0	1,597.0 x 10^{12}	84.0 x 10^{12}

1 Virginia includes an explicit MOS by identifying the TMDL target as achieving the total fecal coliform water quality concentration of 190 cfu/100ml as opposed to the WQS of 200 cfu/ml. This can be viewed explicitly as a 5% MOS.

EPA believes it is important to recognize the conceptual difference between directly deposited loads (loads deposited to the stream) and land applied loads. Directly deposited loads represent the actual amount of fecal coliform being deposited into the stream segments. While values for flux sources (land applied sources) represent the amount of fecal coliform deposited to land. The actual amount of fecal coliform which reaches the stream will be less than the amount of fecal coliform deposited to land due to die-off, geography (distance to the stream), soil, and application method. The HSPF model, which considers landscape processes which affect the total amount of fecal coliform runoff from land uses, determines the amount of fecal coliform which will reach the stream segment. Table 6.3 of the TMDL report illustrates the actual amounts of fecal coliform being transported to Mill Creek.

The United States Fish and Wildlife Service has been provided with a copy of this TMDL.

III. Discussion of Regulatory Conditions

EPA finds that Virginia has provided sufficient information to meet all of the 8 basicrequirements for establishing a fecal coliform TMDL for Mill Creek. EPA is therefore approving this TMDL. Our approval is outlined according to the regulatory requirements listed below.

1) The TMDL is designed to meet the applicable water quality standards.

Virginia has indicated that excessive levels of fecal coliform due to nonpoint sources (directly deposited into the River) have caused violations of the water quality standards and designated uses on Mill Creek. The water quality criterion for fecal coliform is a geometric mean 200 cfu (colony forming units)/100ml or an instantaneous concentration of no more than 1,000 cfu/100ml. Two or more samples over a thirty-day period are required for the geometric mean standard. Therefore, most violations of the State's water quality standard are due to violations of the instantaneous standard.

The HSPF model was used to determine the fecal coliform deposition rates to the land as well as loadings to the stream from point and direct deposition sources necessary to support the fecal coliform water quality criterion and primary contact use. The following discussion is intended to describe how controls on the loading of fecal coliform to Mill Creek will ensure that the criterion is attained.

The TMDL modelers determined the fecal coliform production rates within the watershed. Information was attained from a wide array of sources on the farm practices in the area (land application rates of manure), the amount and concentration of farm animals, point sources in the watershed, animal access to the stream, wildlife in the watershed and their fecal production rates, land uses, weather, stream geometry, etc. This information was put into the model. The model then combines all the data to determine the hydrology and water quality of the stream.

The hydrology component of the model for all the North River TMDLs (Dry River, Mill Creek, and Pleasant Run) was developed on Linville Creek using flow data from 1991 through 1996 and then transferred to each individual watershed. This was done because there were no stream gages on the other waters. When the simulated data on Linville accurately reflected the observed flow data the model was considered complete and transferred to the other watersheds. To verify the transferability of the model, the model was run on Muddy Creek (flow data from 1993 to 1995) and Linville Creek (flow data from 1986 to 1991). The percent error between observed and simulated flows for both validation runs were within the desired criterion of 10%. The winter simulated flow for Muddy Creek was significantly greater (above the 10% desired range) than the observed flow. This may have been caused by a combination of the unusual weather patterns exhibited during the winters of 1994 and 1995 and the short duration of the validation period. The hydrologic parameters were adjusted to match the conditions in each watershed. The model was calibrated by comparing simulated flow results to observed flows(monthly samples).

The model was then transferred to the Mill Creek watershed. The simulated flow data was compared to the 37 monthly flow measurements collected from Mill Creek. Based on this analysis, it was determined that the model was over predicting base flow on Mill Creek. Therefore, two of the hydrology parameters (DEEPFR and IRC) were adjusted to provide a better correlation between the observed and simulated data. By increasing these parameters the modelers removed a portion of groundwater and interflow from the system, lowering base flow.

EPA believes that using HSPF to model and allocate fecal coliform will ensure that the designated uses and water quality standards will be attained and maintained for Mill Creek.

2) The TMDL includes a total allowable load as well as individual waste load allocations and load allocations.

Total Allowable Loads

Virginia indicates that the total allowable loading of fecal coliform is the sum of the loads allocated to land based, precipitation driven nonpoint source areas (cropland, pasture (1, 2, and 3), loafing lots, rural residential, forest) from flux sources, directly deposited nonpoint sources of fecal coliform (cattle in-stream and wildlife in-stream), and point sources. Activities such as the application of manure, fertilizer, and the direct deposition of wastes from grazing animals are considered fluxes to the land use categories. The actual value for the total fecal load can be found in Table #1 of this document. The total allowable load is calculated on an annual basis due to the nature of HSPF model.

Waste Load Allocations

Virginia has stated that there are no point sources discharging to Mill Creek. EPA regulations require that an approvable TMDL include individual WLAs for each point source. According to 40 CFR 122.44(d)(1)(vii)(B), "Effluent limits developed to protect a narrative water quality criterion, a numeric water quality criterion, or both, are consistent with assumptions and requirements of any available WLA for the discharge prepared by the State and approved by EPA pursuant to 40 CFR 130.7." Furthermore, EPA has authority to object to the issuance of any NPDES permit that is inconsistent with the WLAs established for that point source

Load Allocations

According to federal regulations at 40 CFR 130.2 (g), load allocations are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading. Wherever possible natural and nonpoint source loads should be distinguished.

In order to accurately simulate landscape processes and nonpoint source loadings, VADEQ used the HSPF model to represent the Mill Creek watershed. The HSPF model is a comprehensive modeling system for simulation of watershed hydrology, point and nonpoint loadings, and receiving water quality for conventional pollutants and toxicants[2].

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[2] Supra, footnote 2.

More specifically HSPF uses precipitation data for continuous and storm event simulations to determine total fecal loading to Mill Creek from impervious areas, cropland, forest, pasture (1, 2, and 3) loafing lots, rural residential, farmstead, etc. The total land loading of fecal coliform is the result of the application of manure (cattle and poultry wastes), direct deposition from cattle and wildlife (geese, duck, racoon, muskrat, and deer) to the land, fecal coliform production from dogs, and septic system failure.

In addition, VADEQ recognizes the significant loading of fecal coliform from cattle in-stream and wildlife in-stream. These sources are not dependent on a transport mechanism to reach a surface waterbody and therefore impact water quality during low and high flow events. These sources were modeled as though they were point sources.

Climatic data was obtained from the Dale Enterprise weather station. This weather station is located 12.8 miles from the watershed outlet. Precipitation acts as a transport mechanism for land applied loads. Therefore, weather data plays an integral part in the modeling process, affecting the loading to the stream. The average annual precipitation is 33.6 inches with approximately 60% of the precipitation occurring from May to October. Additional climatological information was obtained from weather stations in Monterey Virginia, Lynchburg Airport, and Elkins Airport (West Virginia).

Table #2 - Load allocation for the land application of fecal coliform

Source	Existing Load (cfu/yr)	Allocated Load(cfu/yr)	Percent Reduction
Cropland	77.8E+12	77.8E+12	0%
Pasture 1	1,307.8E+12	1,307.8E+12	0%
Pasture 2	110.7E+12	110.7E+12	0%
Pasture 3	48.0E+12	48.0E+12	0%
Loafing Lots	0.1E+12	0.1E+12	0%
Rural Residential	32.2E+12	32.2E+12	0%
Farmstead	2.7E+12	2.7E+12	0%
Forest	3.9E+12	3.9E+12	0%
Urban Residential	10.6E+12	10.6E+12	0%
Wildlife In-Stream	10.8E+12	3.2E+12	70%
Cattle In-Stream	133.5E+12	0.0	100%

3) The TMDL considers the impacts of background pollution.

The Mill Creek TMDL considered background as being pristine forested conditions. Wildlife was the source of fecal loading for background conditions.

4) The TMDL considers critical environmental conditions.

EPA regulations at 40 CFR 130.7 (c)(1) require TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality of Mill Creek is protected during times when it is most vulnerable.

Critical conditions are important because they describe the factors that combine to cause a violation of water quality standards and will help in identifying the actions that may have to be undertaken to meet water quality standards[3]. Critical conditions are a combination of environmental factors (e.g., flow, temperature, etc.), which have an acceptably low frequency of occurrence but when modeled to, insure that water quality standards will be met for the remainder of conditions. In specifying critical conditions in the waterbody, an attempt is made to use a reasonable "worst-case" scenario condition. For example, stream analysis often uses a low-flow (7Q10) design condition because the ability of the waterbody to assimilate pollutants without exhibiting adverse impacts is at a minimum.

The sources of bacteria for these stream segments were mixtures of dry and wet weather driven sources. The TMDL was modeled to a typical hydrologic year. The Mill Creek watershed is dominated by low flow events. Therefore, if the fecal coliform standard was attained during these low flow events, it would be attained for the year. Low flow events represent the critical condition for Mill Creek.

5) The TMDLs consider seasonal environmental variations.

Seasonal variations involve changes in stream flow as a result of hydrologic and climatological patterns. In the continental United States, seasonally high flow normally occurs in early spring from snow melt and spring rain, while seasonally low flow typically occurs during the warmer summer and early fall drought periods. Consistent with our discussion regarding critical conditions, the HSPF model and TMDL analysis effectively considered seasonal environmental variations. The TMDL clearly considered seasonal environmental variations as the model for Mill Creek was run from 1993 through 1996. The model also accounted for the seasonal variation in loading. Fecal coliform loads changed for many of the sources depending on the time of the year. For example, cattle spent more time in the stream in the summer and animals were confined for longer periods of time in the winter.

6) The TMDLs include a margin of safety.

This requirement is intended to add a level of safety to the modeling process to account for any uncertainty. Margins of safety may be implicit, built into the modeling process by using conservative modeling assumptions, or explicit, taken as a percentage of the wasteload allocation, load allocation, or TMDL.

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[3]EPA memorandum regarding EPA Actions to Support High Quality TMDLs from Robert H. Wayland III, Director, Office of Wetlands, Oceans, and Watersheds to the Regional Management Division Directors, August 9, 1999.

Virginia used an explicit margin of safety by establishing the TMDL target water quality concentration for fecal coliform at 190 cfu/ 100mL, which is more stringent than Virginia's water quality standard of 200 cfu/100 mL.

7) The TMDLs have been subject to public participation.

This TMDL was subject to a number of public meetings. Three public meetings were held in Dayton, VA. The meeting were held on December 09, 1999, January 20, 2000, and March 28, 2000 and were intended to address initial questions and concerns regarding outreach issues and the TMDL process.

The first public meeting was held on December 9, 1999 in Dayton and was announced in the Virginia Register on November 03, 1999. The second public meeting was announced in the Virginia Register on December 14, 1999. The March 28, 2000, public meeting was announced in the March 13, 2000 Virginia Register and the local. No written comments were submitted by the general public.

8) There is a reasonable assurance that the TMDL can be met.

EPA requires that there be a reasonable assurance that the TMDL can be implemented. WLAs will be implemented through the NPDES permit process. According to 40 CFR 122.44(d)(1)(vii)(B), the effluent limitations for an NPDES permit must be consistent with the assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA. Furthermore, EPA has authority to object to issuance of an NPDES permit that is inconsistent with WLAs established for that point source.

Nonpoint source controls to achieve LAs can be implemented through a number of existing programs such as Section 319 of the Clean Water Act, commonly referred to as the Nonpoint Source Program. Additionally, Virginia's Unified Watershed Assessment, an element of the Clean Water Action Plan, could provide assistance in implementing this TMDL.